

TROPICAL DEPRESSION 16
AND TYPHOON ORCHID (17)



FIGURE 3-17-1. Satellite imagery showing extensive unorganized convection in the vicinity of Guam, 05 September 1980, 2150Z (NOAA6 imagery). This imagery along with synoptic and aircraft data supported the decision to issue the final warning on TD 16. The increased convection east and north of Guam also alerted JTWC to the possible development of another disturbance between Guam and Saipan.

The discussion for Typhoon Orchid would be incomplete without reviewing the brief life of Tropical Depression 16. Both systems developed near the eastern extension of the monsoon trough. The dissipation of Tropical Depression 16 was followed by the subsequent development of the disturbance which became Typhoon Orchid. The influence of the monsoon trough was investigated to explain the structure of these cyclones and, ultimately, to offer an explanation for Orchid's most unusual behavior south of Japan.

During the first few days of September, the monsoon trough was evident as far east as 160E along 05N. Satellite imagery on 2 September indicated increased convection near a weak circulation at the eastern end of the trough. The first of two formation alerts was issued at 021400Z. Further development was not observed on satellite imagery during the next 36 hours. A reconnaissance aircraft at 040155Z located a closed surface circulation with 25 kt (13 m/sec) maximum winds and a minimum sea-level pressure of 1002 mb. The first warning on TD 16 followed at 040600Z,

and during the next 42 hours, JTWC tracked the depression as it moved west-northwestward. Aircraft investigations during this period showed a largely unorganized system. Unlike the investigation at 040155Z, these investigations repeatedly suggested that multiple centers existed in the area. Post-analysis indicated that sometime during the 42-hour period, the surface center associated with TD 16 weakened within the trough while JTWC continued to follow a persistent convective center to the west.

Although TD 16 continued to weaken, warnings were still issued because the potential for significant tropical cyclone development remained high in the region. Another disturbance eventually developed northeast of TD 16 as TD 16 weakened. Satellite imagery received at 052150Z (Fig. 3-17-1) showed that the entire area near Guam was under extensive, but apparently unorganized convection. The final warning was issued for TD 16 when aircraft reconnaissance at 060050Z failed to locate a significant surface circulation.

By 060000Z, satellite imagery indicated that a tropical cyclone formation alert was required for a rapidly developing disturbance just north of Guam. A reconnaissance aircraft investigated the disturbance at 060120Z but was unable to close a surface circulation. The aircraft and synoptic data showed an extensive light and variable wind area extending more than 100 nm (185 km) west of the disturbance. Synoptic data, nevertheless, indicated that gale force winds (greater than 33 kt (17 m/sec)) existed in the eastern semicircle of the disturbance. After coordination with forecasters at Naval Oceanography Command Center, Guam¹, a gale warning was issued for the area. The first warning for Tropical Storm Orchid was issued at 070200Z. This warning was based on aircraft reconnaissance at 070005Z which observed 45 kt (23 m/sec) surface winds in the northeast quadrant of the storm. The same aircraft observed only 10-15 kt (5-8 m/sec) northwest winds in the western quadrant, indicating that a closed surface circulation existed only for 6-12 hours before the first warning

on Tropical Storm Orchid.

During the five-day period from 02 to 08 September, the axis of the monsoon trough moved from 05N to 18N. A near equatorial or buffer ridge developed at low latitudes and extended from the Philippines to the east of Orchid. The pre-existing subtropical ridge north of Orchid and the presence of the near equatorial ridge provided a broad wind band, which extended counter-clockwise from the south-southwest of Orchid to the northwest at distances as far as 800 nm (1482 km) from Orchid's center. A composite surface streamline analysis from 07000Z to 091200Z indicates that this pattern maintained itself, virtually unchanged, during a 60-hour period during which Orchid moved west-northwest at 12 kt (22 km/hr). Figure 3-17-2 shows this pattern with the 081200Z surface wind field around Orchid superimposed. After 091200Z, the northwest wind component strengthened around Orchid as the monsoon trough began interacting with a mid-latitude trough in the east China Sea.

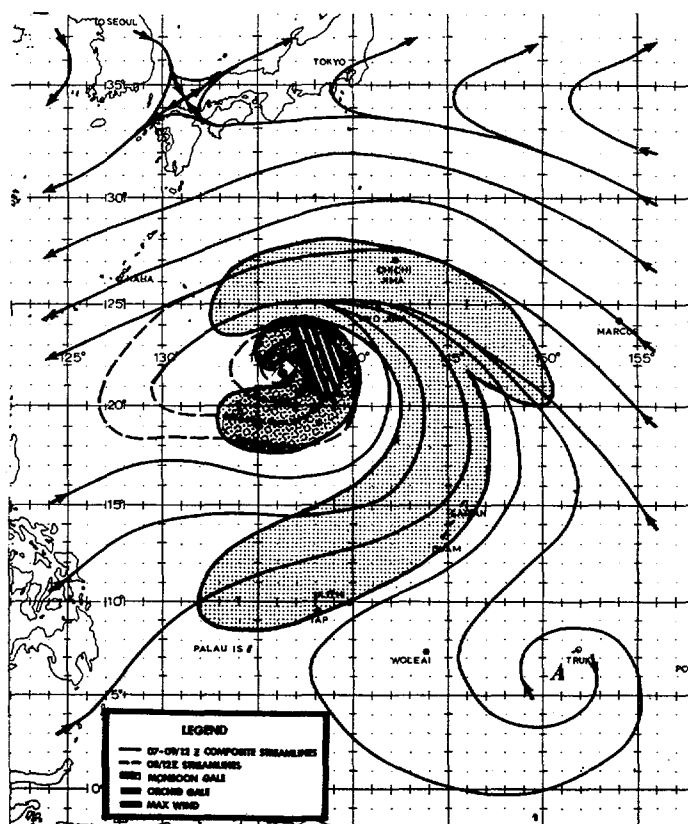


FIGURE 3-17-2. A composite surface streamline analysis of the monsoon trough based on data collected from 070000Z to 091200Z. The 081200Z streamlines (dashed lines) are superimposed for Orchid.

¹ The Joint Typhoon Warning Center functions operationally under the command of the Naval Oceanography Command Center, Guam (NOCC). Destructive wind warnings for the western North Pacific are included in the services provided by NOCC.

Although TD 16 and Typhoon Orchid developed in the same location with respect to the monsoon trough, it now appears that TD 16 failed to intensify because it could not sustain its own circulation pattern independent of the enhanced flow around the trough. Orchid sustained an independent circulation beginning on 7 September.

By 090000Z, Orchid had moved north into the subtropical latitudes near 23N. The monsoon trough was showing signs of weakening, and by 091800Z, the eastern portion of the wind band collapsed into Orchid's circulation pattern. Interaction with the mid-latitude trough moving east from Asia signalled the beginning of a change in Orchid's trajectory towards recurvature. The numerical prognostic series indicated a further eastward progression of the mid-latitude trough, but the series did not reflect the presence of Orchid at the middle and upper levels of the troposphere. Initial recurvature tracks anticipated a deepening of the trough and eventual recurvature southeast of Japan. The trough stalled near 130E, however, and the opportunity for recurvature was delayed until Orchid approached the Ryukyu Islands about 12 to 18 hours later.

In post-analysis, JTWC often finds some phenomenon that is not evident to the forecaster in real-time but which explains the motion or character of a tropical cyclone. In Orchid's case, JTWC was well aware of her circulation pattern; what wasn't known was the effect of this circulation pattern on Orchid's trajectory. Once formed, Orchid moved to the west-northwest at a nearly constant speed. During this portion of her track, Orchid was well behaved and there was no known "rule of thumb" which would have provided JTWC with a prior warning of the motion that the cyclone would undergo in the 36-hour period beginning at 090600Z. Beginning at 090600Z, Orchid executed three high speed cyclonic loops while maintaining an overall forward speed of 14 kt (26 km/hr) toward the north. Satellite, aircraft, and radar surveillance provided dense reconnaissance coverage of Orchid during these loops (Fig. 3-17-3). Orchid finally stabilized on her northward track just prior to landfall on Kyushu, Japan. Figure 3-17-4 illustrates an expanded surface best track, a partial 700 mb track based on aircraft data, and the overall smoothed track, which may have been followed by Orchid at some level above 700 mb. An analogy which may offer some insight into Orchid's unexplained motion is given next.

Before offering the analogy, some conjecture is required based on the assumption that Orchid's circulation pattern relative to the broad-scale circulation was "conditionally" unstable, i.e., all the forces acting on Orchid were only in balance as long as she maintained a constant heading. As Orchid approached the mid-latitude trough, this balance was interrupted and the potential unstable character of the cyclone, embedded in this particular synoptic pattern, was realized. One analogy that can be used to explain the trajectory involves a child's toy top. The top, inherently unstable because of its small base and wide body, will spin uniformly about its axis as long as it maintains equilibrium. A

loss of rotational speed or a tap along the side will cause the top to stumble and the base will appear to accelerate along a predictable looping pattern until the top's stability is either restored or it comes to rest.

It is suggested here that the effect was virtually the same when Orchid began interacting with the mid-latitude trough. The best track shows that Orchid regained her equilibrium within the mid-latitude trough prior to making landfall in southern Japan. Orchid did not loop again and she returned to a slower speed of 18 kt (33 km/hr) prior to accelerating during the extratropical transition period.

Orchid caused considerable damage and loss of life in Japan and Korea. High winds and torrential rains associated with Orchid were blamed for six deaths, numerous injuries, and considerable damage to crops in southern Japan. At least three deaths were reported in South Korea as Orchid moved east of Korea into the Sea of Japan. Another 112 fishermen were reported missing in the Korea Straits following Orchid's passage.

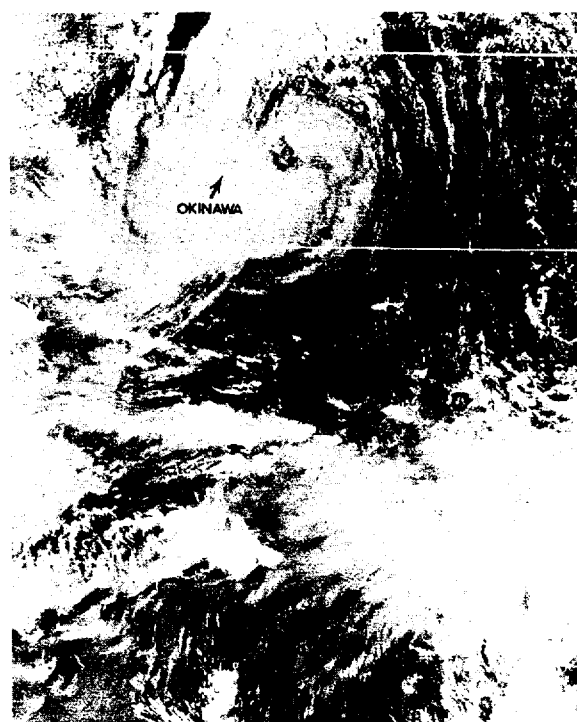


FIGURE 3-17-3. Typhoon Orchid, near maximum intensity, completing the second of three cyclonic loops, 10 September 1980, 0625Z. [TIROS imagery]

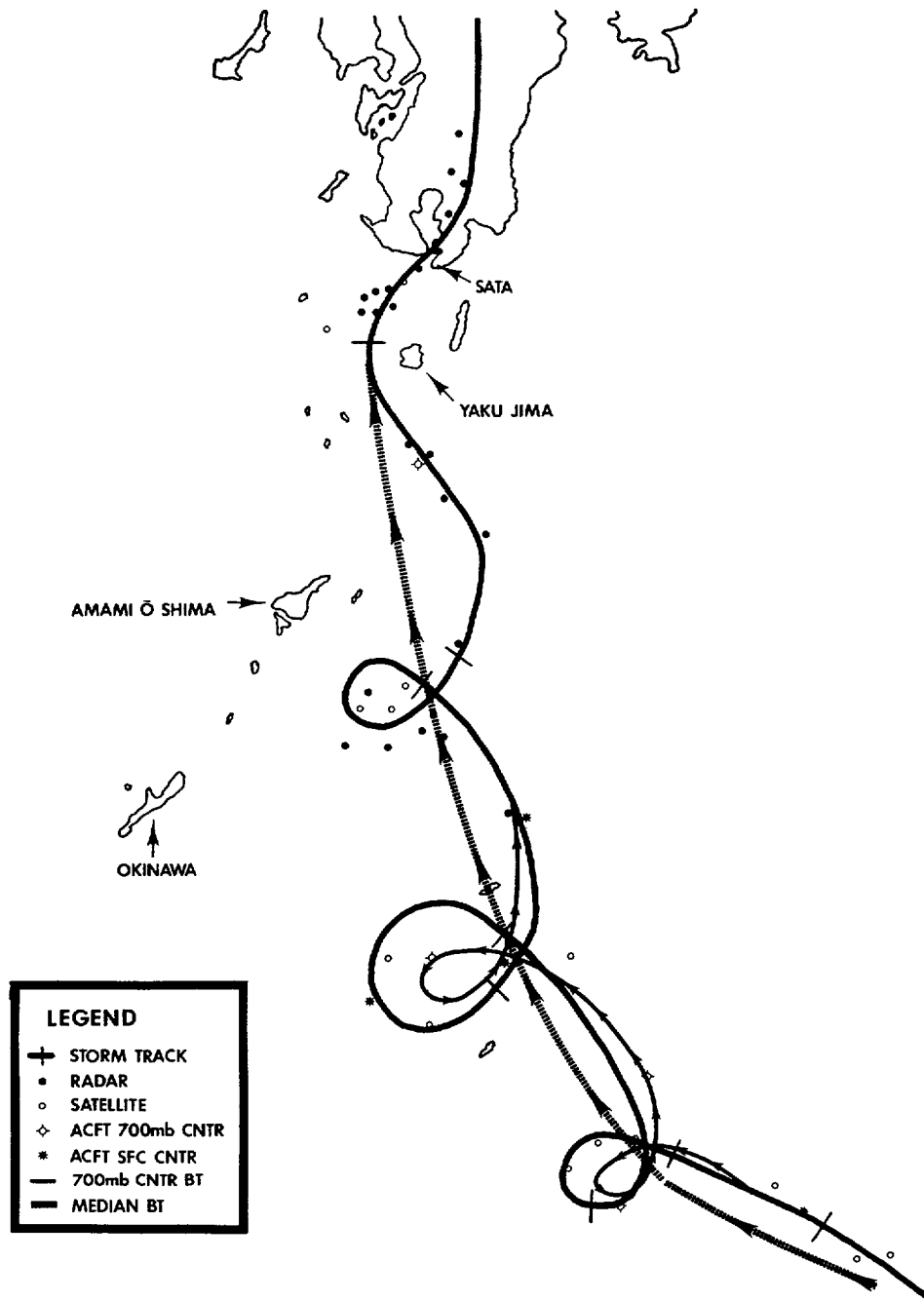


FIGURE 3-17-4. An expanded best track from 090600Z to 170000Z. The figure shows the distribution of fix positions, a partial 700 mb track, and an overall smoothed track.